



& Jabeen, 2009; Ekin, 2010; Jalaluddin & Hamid, 2011; Jalilian et al., 2012).

Several Researchers have claimed the positive relationship between Integrated Nutrient practices and vegetative growth of crops. According to a significant increase in vegetative growth of sunflower in terms of plant height, leaf area, stem and disc diameter, fresh and biomass was observed under the Balanced and integrated use of organic manures along with inorganic fertilizers (Ahmad & Jabeen, 2009). Researchers pointed like (Figure 1) have also demonstrated such similar impact of Integrated nutrient management on the vegetative growth of okra, onion, paddy, and cotton respectively (Moench et al., 2019; Meena et al., 2016; Roy et al., 2001; Mahavishnan, 2005). This increment in vegetative growth could be attributed to the synergistic effects of combined fertilizers that improve the physicochemical properties of soil like increase in hydraulic conductivity, soil aggregation, penetration resistance, low bulk density, and proper aeration (Baghbani-Arani et al., 2020; Riwardi et al., 2018; Wu & Ma, 2015). The research conducted at the research farm of Indian institute of Soil science, Bhopal, India has shown that the plots receiving both NPK and FYM had lower bulk density whereas in it was highest in control plots (Hati et al., 2006). Moreover, Rational use of organic manures in combination with inorganic fertilizers increases the availability of nutrients like Fe, Zn, K, P and enhances their uptake as well (Mathers et al., 1980). Others reported that Integrated Nutrient Management enhances the supply of plant growth-promoting substances such as auxin, amino acids, and vitamins which in turn promotes the vegetative growth of a plant (Moench et al., 2019). This finding was similar to that of Marschner (1991) who reported that the secretion of auxin in the apoplast of the epidermis regulates the extension growth. Furthermore, the Substitution of certain amounts of chemical fertilizers with manure FYM in water deficit condition enhances the Water Use Efficiency, improves the leaf water potential osmotic potential, and mitigate the salinity problem of sandy soil which has a profound impact on the growth of sunflower (Ahmad & Jabeen, 2009).

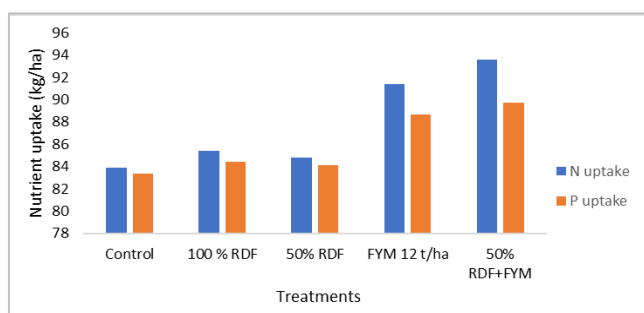


Figure 1: Effect of INM on Nutrient uptake (Mahavishnan et al., 2005)

## 2.2 Grain and Biological Yield

The study of (2011a) has demonstrated that the highest grain yield (2823.3 kg/ha) and maximum biological yield (9917.9 kg/ha) of sunflower were obtained in the integrated treatment of 50% FYM and 50% RDF over other treatments. This finding was in harmony with who reported that the yield of sesame was significantly influenced by the conjugational application of organic and inorganic fertilizers (Nayek et al., 2014; Sahu et al., 2017). In a recent studt have been also reported similar effects of Integrated Nutrient Management in the yield of okra (Ghugre, 2015; Sachan et al., 2017; Mishra et al., 2020). More availability of major nutrients like N, P, K and their uptake due to the complementary effect of organic and Mineral fertilizers could account for the increment in yield of crops (Azeez & Van Averbek, 2010; Munir et al., 2007). According to (Meena et al., 2016), Nutrient Management enhances phosphorus availability as the decomposition of organic manures produces the solubilizing organic acids which make the adsorbed and immobilized phosphorus available to the plant. (Munir et al., 2007) concluded that the Net assimilation rate of sunflower was better under integrated Nutrient management practices where the maximum Net Assimilation Rate (9.75 g/m<sup>2</sup>/day) were recorded in the treatment of 50-75-50 kg NPK per hectare along with poultry manure at 8 t/ha. Furthermore, Integrated Nutrient Management is also responsible for the enhancement of Carbon sequestration and maximum water use efficiency thus resulting in root proliferation and maximum water use efficiency (Hati et al., 2006; Phonglosa et al., 2015). According to (2007), Integrated use of organic manures and NP fertilizers for 10 years resulted in an increased organic content, where the highest organic Carbon (0.99%) was observed when 15000kg FYM + 150 kg N + 30

kg p<sub>2</sub>o<sub>5</sub> per hectare for 10 years was applied. This might be due to the addition of organic matter through organic manures resulting high

buildup of organic matter in the soil (Bandyopadhyay et al., 2010; Roy et al., 2001). Seed treatment with plant beneficial micro-organism were reported to improve nutrient use efficiency and reduce the chemical fertilizer requirement to some extent (Jalaluddin & Hamid, 2011). INM practice with incorporation of microbes is under action in various parts of world and is current interest of research. Use of phosphate solubilising micro-organism not only improves the phosphate availability in soil but also its use efficiency and economics of phosphate use to soil with improving yield attributing traits of sunflower which increases the seed yield (Ekin, 2010).

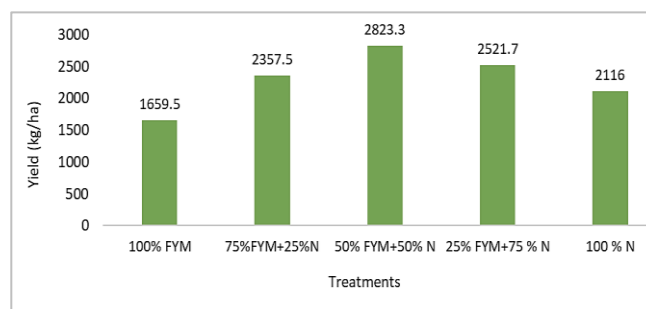


Figure 1: Effect of fertility management practices on Yield

## 2.3 Seed Protein Content

Ample evidence exists to support that the integrated use of organic and mineral fertilizers significantly influences the seed protein content and protein yield per ha.

A study found that the plots treated with 50 % FYM and 50 % RDF (Figure 2) resulted in the maximum protein content (20.2%) and protein Yield per ha (572.8 kg) whereas the minimum protein content of 17.7 % and protein Yield per ha (303.9 kg) was recorded in the treatment of 100 % FYM (Akbari et al., 2011a).

Similarly, the Highest seed yields of 2250 kg/ha and 2247 kg /ha were obtained under RDF (62.5:75:62.5 kg NPK /ha) coupled with 14 t FYM /ha (Nanjundappa et al., 2001). He also observed that there was a 22% increase in seed yield by the application of RDF and 14 t FYM /ha over the application of RDF alone. The enhancement of Nitrogen Use efficiency and its abundant availability due to the complementary interactions of organic and inorganic fertilizers could account for the increment in seed protein content (Gholamhoseini et al., 2013b; Graham et al., 2017). Also observed the similar impact of Integrated Nutrient Management on Nitrogen Use Efficiency of rice (2003). Moreover, the higher carbon content of the organic manures encourages the proliferation of the microbes and the proper use of available Nitrogen required for cell metabolism (Azeez & Van Averbek, 2010). Thus, the Application of organic manures increases the soluble proteins with better Nitrogen supply thus promoting the amino acid synthesis in leaves and resulting high accumulation of protein in seed (Akbari et al., 2011; Spencer, 1954). However, this finding contradicts the result of (1999) who concluded that aerobically decomposed cattle manure immobilizes the chemical fertilizer N applied at the same time and does not contribute to the supply of nutrients to crops in short term.

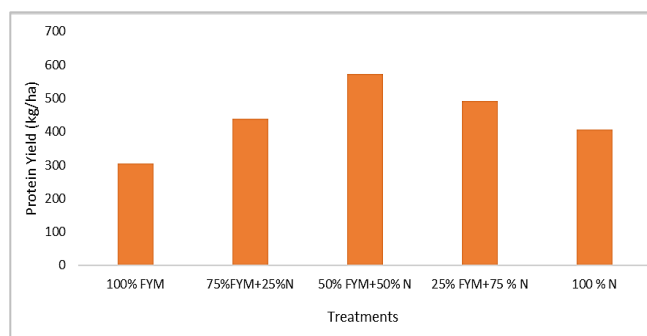


Figure 2: Effect of INM on protein yield.

## 2.4 Seed Oil Content and Yield

A number of recent studies have found concrete evidence that various nutrient management practices influence the seed oil content and seed yield of sunflowers. Among several integrated nutrient treatments, the

highest oil content (49.4 %) and oil yield per ha ( 1275.9 kg ) were observed under 100 % FYM and 100 % FYM with 50 % respectively (Akbari et al., 2011a). Similar findings were observed in sesame where the integration of NPK, FYM with Azospirillum gave the highest oil yield (Tripathi et al., 2011). This data reveals that the oil content and oil yield of sunflowers are significantly influenced by various nutrient management practices. There is an adverse effect of excess nitrogen on oil content which suggests that the sole application of chemical fertilizers results in less oil content in sunflower (Akbari et al., 2011a) (Figure 3).

According to recent study, protein competes strongly for photosynthates due to which less Nitrogen is available for oil synthesis (Akbari et al., 2011b; Munir et al., 2007). Moreover, the Seed oil content of Sunflower is significantly affected by water availability and water-deficient condition reduces the seed oil content as there is a positive correlation between water potential and seed oil content (Gholamhoseini et al., 2013). Thus, Integrated Nutrient Management enhances the Water Use efficiency of crops, thus increasing the seed oil content. However, researchers reported that the seed oil content was not influenced by the application of an organic or inorganic source of nutrients (Nanjundappa et al., 2001).

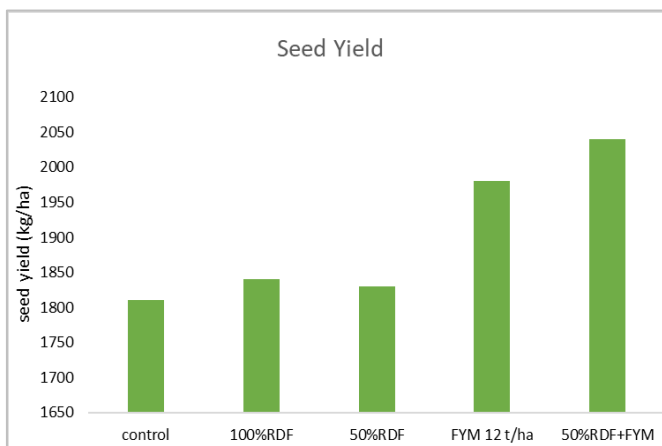


Figure 3: Effects of INM on seed Yield of Sunflower

### 2.5 Oil fatty acids Composition

The composition of fatty acid is the main determinant of the oil quality in sunflower (Akbari et al., 2011) (Figure 4).

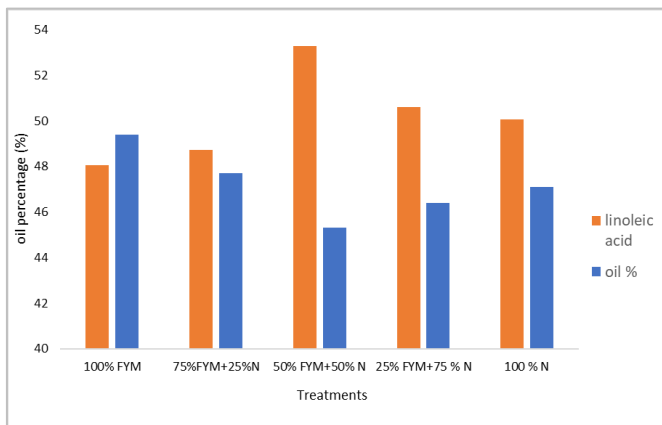


Figure 4: Effect of INM on oil fatty acid composition.

Fatty acids of sunflower oil contain both saturated as well as unsaturated fats. Since saturated acid tends to increase the blood cholesterol level, low saturated fatty acids with a high concentration of unsaturated fat are desirable for consumption (Akbari et al., 2011). According to him, Oleic and Linoleic acid account for more than 90% of the unsaturated fatty acid content in sunflower whereas Palmitic acid is the dominant saturated fatty acid. The highest linoleic concentration and lowest concentration of oleic acid were found in the treatment 50%FYM and 50 % N which is desirable for human consumption (Akbari et al., 2011). Similarly, Maximum Linoleic acid (49.72%) was obtained in treatment 50-75-50 NPK kg/ha along with Poultry manure at 8t/ha whereas minimum linoleic acid (48.06) was observed in the treatment 100 %FYM (Munir et al., 2007). This shows that Nitrogen supply rates affect the fatty acid composition where a Higher Nitrogen rate increases the percentage of unsaturated fatty acids and decrease saturated fatty acids. Thus, Integrated nutrient management

causes a significant decrease in the saturated fatty acids (palmitic acid and stearic acid) while resulting in a significant increase in unsaturated fatty acids, compared with the untreated plant (Munir et al., 2007).

### 3. CONCLUSION

Although sunflower production has tremendous advantages due to its adaptability to a wide range of soils and climatic conditions, lower seed rate, short duration, high content of quality cooking oil, high seed multiplication ratio, and higher profitability but its production and oil quantity has not been increased in decades. Declining soil fertility due to the imbalanced and excessive use of chemical fertilizers has limited global sunflower production. Therefore, there is a need to improve sunflower production to meet the edible oil requirements for the increasing population. Over the years, Several research attempts have been made on nutrient management practices for sunflowers at different research institutions. Recent studies have demonstrated the positive impact of Integrated Nutrient Management on the vegetative growth, biological yield, seed protein content, and oil yield of sunflowers. Moreover, the Balanced use of organic and inorganic fertilizers enhances the fertility of the soil improving its physical, chemical, and biological properties. Thus, the findings of various researches on Integrated Nutrient Management suggest the use of 50% FYM and 50% Recommended dose of inorganic fertilizers for optimal production of sunflower which has positive effect on seed yield and oil recovery. While there has been a great deal of research on the influence of Integrated Nutrient management practices on soil properties, important questions regarding the influence of soil type in particular Nutrient Management practices are questionable. A limited number of studies have addressed the impact of Integrated Nutrient Management practices on the oil fatty acid composition which deserves more attention.

proper quarantine measures. Outbreaks of insect pests in Indian sub-continent are mainly associated with the cultivation of modern varieties lacking insect resistance. In addition to it, year-round cultivation of rice, use of high levels of nitrogen fertilizers and extensive use of insecticides have increased the frequency of outbreaks. (Chelliah et al., 1989).

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